B1 Cont'd

calculating a desired pressure value using the determined phase and a desired ventilation; and

delivering ventilation to said patient in accordance with said desired pressure value.

2. (AMENDED) The method of claim 1 wherein said respiratory effort sensor is selected from a group of effort sensors including:

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(a) a suprasternal notch sensor;

(b) an esophageal pressure effort sensor; and

(c) an electromyograph.

3. The method of claim 1 wherein said phase determining step comprises evaluating fuzzy inference rules relating to said signal from said respiratory effort sensor.

4. The method of claim 3 wherein said phase determining step further comprises evaluating fuzzy inference rules relating to the rate of change of said signal from said respiratory effort sensor.

5. The method of claim 4 wherein said phase determining step further includes the sub-step of evaluating fuzzy logic inference rules relating to the measured respiratory airflow.

6. The method of claim 5 wherein said phase determining step further includes the sub-step of evaluating fuzzy logic inference rules relating to the rate of change of the measured respiratory airflow.

7. The method of claim 1 wherein said phase determining step further includes the sub-step of evaluating fuzzy logic inference rules relating to the measured respiratory airflow.

8. The method of claim 7 wherein said phase determining step further includes the sub-step of evaluating fuzzy logic inference rules relating to the rate of change of the measured respiratory airflow.

9. The method of claim 1 wherein the desired ventilation has a non-zero minimum value and a maximum value.

10. The method of claim 9 wherein said step of calculating a desired pressure value includes deriving an error value that is a function of the difference between calculated patient ventilation and a target value.

11. The method of claim 4 wherein said fuzzy inference rules include at least one rule selected from a group of rules including:

(a) If the effort signal is zero and increasing fast, then the phase is about 0 revolutions;

(b) If the effort signal is medium and increasing moderately, then the phase is about 0.2 revolutions;

(c) If the effort signal is large and decreasing fast, then the phase is about 0.5 revolutions; and

(d) If the effort signal is medium and decreasing moderately, then the phase is about 0.7 revolutions.

12. The method of claim 4 wherein said fuzzy inference rules include a rule in which the start of inspiration is associated with approximately zero respiratory effort which is increasing fast.

13. The method of claim 4 wherein said fuzzy inference rules include a rule in which mid-inspiration is associated with medium respiratory effort which is increasing moderately.

14. The method of claim 4 wherein said fuzzy inference rules include a rule in which the beginning of expiration is associated with large respiratory effort which is decreasing fast.

15. The method of claim 4 wherein said fuzzy inference rules include a rule in which mid-expiration is associated with medium respiratory effort which is decreasing moderately.

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16. (AMENDED) The method of claim 6 wherein said fuzzy inference rules include at least one rule selected from a group of rules including:

(a) If the airflow is zero and increasing fast, then the phase is about 0 revolutions;

(b) If the airflow is large positive and steady, then the phase is about 0.25 revolutions;

(c) If the airflow is zero and falling fast, then the phase is about 0.5 revolutions;

(d) If the airflow is large negative and steady, then the phase is about 0.75 revolutions;

(e) If the airflow is zero and steady and the 5-second low-pass filtered absolute value of the respiratory airflow is large, then the phase is about 0.9 revolutions;

(f) If the airflow is positive and the phase is expiratory, then the phase is about 0.1 revolutions;

(g) If the airflow is negative and the phase is inspiratory, then the phase is about 0.6 revolutions;

(h) If the 5-second low-pass filtered absolute value of the respiratory airflow is small, then the phase in the respiratory cycle is increasing at a fixed rate equal to the patient's expected respiratory rate; and

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(i) If the 5-second low-pass filtered absolute value of the respiratory airflow is large, then the phase in the respiratory cycle is increasing at a steady rate equal to the existing rate of change of phase, low-pass filtered with a time constant of 20 seconds.

17. An apparatus for providing synchronized ventilatory support to a patient comprising:

at least one sensor to generate a respiratory effort signal;

a processor for analyzing both respiratory airflow and said effort signal to determine the instantaneous respiratory phase of the patient and to generate a desired pressure request signal as a function of said instantaneous respiratory phase and a desired ventilation; and

a servo-controlled blower to provide pressurized air to said patient in accordance with said pressure request signal.

B3

18. (AMENDED) The apparatus of claim 17 wherein said at least one sensor is an effort sensor from a group of effort sensors including:

(a) a suprasternal notch sensor;

(b) an esophageal pressure effort sensor; and

(c) an electromyograph.

19. The apparatus of claim 17 wherein said processor evaluates fuzzy inference rules relating to said respiratory effort signal.

20. The apparatus of claim 18 wherein said processor evaluates fuzzy inference rules relating to the rate of change of said respiratory effort signal.

21. The apparatus of claim 20 wherein said processor evaluates fuzzy logic inference rules relating to the respiratory airflow.

22. The apparatus of claim 21 wherein said processor evaluates fuzzy logic inference rules relating to the rate of change of the respiratory airflow.

23. The apparatus of claim 17 wherein said processor evaluates fuzzy logic inference rules relating to the respiratory airflow.

24. The apparatus of claim 23 wherein said processor evaluates fuzzy logic inference rules relating to the rate of change of the respiratory airflow.

25. The apparatus of claim 17 wherein the desired ventilation has a non-zero minimum value and a maximum value.

26. The apparatus of claim 25 wherein the generation of said desired pressure request signal includes deriving an error value that is a function of the difference between calculated patient ventilation and a target value.

27. The apparatus of claim 20 wherein said fuzzy inference rules include at least one rule selected from a group of rules including:

(a) If the effort signal is zero and increasing fast, then the phase is about 0 revolutions;

(b) If the effort signal is medium and increasing moderately, then the phase is about 0.2 revolutions;

(c) If the effort signal is large and decreasing fast, then the phase is about 0.5 revolutions; and

(d) If the effort signal is medium and decreasing moderately, then the phase is about 0.7 revolutions.

28. The apparatus of claim 20 wherein said fuzzy inference rules include a rule in which the start of inspiration is associated with approximately zero respiratory effort which is increasing fast.

29. The apparatus of claim 20 wherein said fuzzy inference rules include a rule in which mid-inspiration is associated with medium respiratory effort which is increasing moderately.

30. The apparatus of claim 20 wherein said fuzzy inference rules include a rule in which the beginning of expiration is associated with large respiratory effort which is decreasing fast.

31. The apparatus of claim 20 wherein said fuzzy inference rules include a rule in which mid-expiration is associated with medium respiratory effort which is decreasing moderately.

32. (AMENDED) The apparatus of claim 22 wherein said fuzzy inference rules include at least one rule selected form a group of rules including:

(a) If the airflow is zero and increasing fast, then the phase is about 0 revolutions;

(b) If the airflow is large positive and steady, then the phase is about 0.25 revolutions;

(c) If the airflow is zero and falling fast, then the phase is about 0.5 revolutions;

(d) If the airflow is large negative and steady, then the phase is about 0.75 revolutions;

A4 Cont'd

(e) If the airflow is zero and steady and the 5-second low-pass filtered absolute value of the respiratory airflow is large, then the phase is about 0.9 revolutions;

(f) If the airflow is positive and the phase is expiratory, then the phase is about 0.1 revolutions;

(g) If the airflow is negative and the phase is inspiratory, then the phase is about 0.6 revolutions;

(h) If the 5-second low-pass filtered absolute value of the respiratory airflow is small, then the phase in the respiratory cycle is increasing at a fixed rate equal to the patient's expected respiratory rate; and

(i) If the 5-second low-pass filtered absolute value of the respiratory airflow is large, then the phase in the respiratory cycle is increasing at a steady rate equal to the existing rate of change of phase, low-pass filtered with a time constant of 20 seconds.

33. A method of providing synchronized ventilatory support to a patient comprising the steps of:

determining the patient's instantaneous respiration phase at least in part from a signal from a respiratory effort sensor,

calculating a desired pressure value using the determined phase and a desired ventilation; and

delivering ventilation to said patient in accordance with said desired pressure value.

A5

34. (AMENDED) The method of claim 33 wherein said respiratory effort sensor is selected from a group of effort sensors including:

(a) a suprasternal notch sensor;

(b) an esophageal pressure effort sensor; and

(c) an electromyograph.

35. The method of claim 34 wherein said phase determining step comprises evaluating fuzzy inference rules relating to said signal from said respiratory effort sensor.

36. The method of claim 35 wherein said phase determining step further comprises evaluating fuzzy logic inference rules relating to the rate of change of said signal from said respiratory effort sensor.

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37. An apparatus for providing synchronized ventilatory support to a patient comprising:

at least one sensor to generate a respiratory effort signal;

a processor for analyzing said effort signal to determine the instantaneous respiratory phase of the patient and to generate a desired pressure request signal as a function of said instantaneous respiratory phase and a desired ventilation; and

a servo-controlled blower to provide pressurized air to said patient in accordance with said pressure request signal.

A4

38. (AMENDED) The apparatus of claim 37 wherein said at least one sensor is an effort sensor from a group of effort sensors including:

(a) a suprasternal notch sensor;

(b) an esophageal pressure effort sensor; and

(c) an electromyograph.

39. The apparatus of claim 38 wherein said processor evaluates fuzzy inference rules relating to said respiratory effort signal.